



## Review article

## Hyperlexia: Systematic review, neurocognitive modelling, and outcome



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## ARTICLE INFO

## Keywords:

Hyperlexia

Autism

Reading

Decoding

Review

Enhanced perceptual functioning model

Visual word form area

## ABSTRACT

Hyperlexia is defined as the co-occurrence of advanced reading skills relative to comprehension skills or general intelligence, the early acquisition of reading skills without explicit teaching, and a strong orientation toward written material, generally in the context of a neurodevelopmental disorder. In this systematic review of cases (N = 82) and group studies (including 912 participants of which 315 are hyperlexic), we address: whether the hyperlexic profile is associated with autism and why, whether models of non-autistic reading can teach us about hyperlexia, and what additional information we can get from models specific to autistic cognitive functioning. We find that hyperlexia, or a hyperlexic-like profile, characterises a substantial portion of the autistic spectrum, in which the subcomponents of the typical reading architecture are altered and dissociated. Autistic children follow a chronologically inverted path when learning to read, and make extended use of the perceptual expertise system, specifically the visual word form recognition systems. We conclude by discussing the possible use of hyperlexic skills in intervention.

## 1. Introduction and definition

The term “hyperlexia” was coined in 1967 by Silberberg and Silberberg (1968), Silberberg and Silberberg (1967). Four features consistently describe hyperlexia: (1) the presence of an accompanying neurodevelopmental disorder; (2) advanced reading skills, relative to comprehension skills or general intelligence; (3) an early acquisition of reading skills without explicit teaching; and (4) a strong orientation toward reading material (Needleman, 1982). The same year, Rutter and Lockyer noticed that the same proportion of both their groups of “psychotic children” and control children could read at a normal level for their age, despite very little schooling for the “psychotic” group. They described the example of a boy who could read well above the average level, although he had been excluded from school at the age of six (Rutter and Lockyer, 1967). However, cases of hyperlexia were described as early as 1930 (Phillips), i.e. before the introduction of both hyperlexia and autism as a syndrome. Mentions of the hyperlexic profile can be found even earlier, in 1918, when Hollingworth and Winford wrote, “Cases where a generally stupid (*sic*) child is innately gifted with special ability to master the mechanics of reading, for

example, are no doubt as frequent as cases where a generally capable child learns them with difficulty.” (Hollingworth and Winford, 1918; cited in Thompson, 1966; p.24).

Fifty years after the term was first introduced, hyperlexia is often reported as one of the savant abilities in autism. However, its neurocognitive underpinning and how it relates to autistic cognition and typical reading acquisition, are yet to be established. Literature on hyperlexia consists of a large number of descriptive reports, combined with a small number of empirical studies testing specific assumptions about its prevalence and mechanisms. Beyond the established cross-sectional differences in decoding and understanding abilities, the distinct, developmental pathway of hyperlexics remains to be characterized. The last academic review on hyperlexia was published 14 years ago (Grigorenko et al., 2003). Multiple case and group studies have been published in the last decade, including the first imaging studies of hyperlexia, making a new review necessary.

Based on a systematic review, we first report the current state of knowledge on the prevalence of hyperlexia and its relation with autism. We present the cognitive processes underlying reading in non-hyperlexic, mature readers, and the sequence of typical reading acquisition.

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<http://dx.doi.org/10.1016/j.neubiorev.2017.04.029>

Received 18 October 2016; Received in revised form 4 April 2017; Accepted 30 April 2017

Available online 03 May 2017

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**Table 1**

Systematic review of hyperlexic case reports – \*The number of criteria for hyperlexia refers to the four-feature definition given in section 1. \*\*The oral language level is classified based on the indications used to determine the ADOS module: 1 refers to individuals with *no speech*, or who do not consistently use phrase speech; 2 refers to individuals with some *phrase speech* (defined as non-echoed three-word utterances that sometimes involve a verb and are spontaneous, meaningful word combinations), but not verbally fluent; 3 refers to fluent speech. *Verbal fluency* is broadly defined as having the expressive language of a typical four-year-old child: producing a range of sentence types and grammatical forms, using language to provide information about events, and producing logical connections within sentences (e.g., “but” or “though”). \*\*\*The autistic diagnosis is determined as explained in 3.2. Additional information on the scoring system can be obtained from the authors on request.

Publication	Case	Gender	Age at time of report (y = years, m = months)	Hyperlexic features mentionned* (1–4)	Reported onset of hyperlexia	Oral language level**	Autism-PDD mentionned	Autistic traits based on description***	Other condition mentionned- not autistic	Not enough information for autism diagnosis
Phillips (1930)	Gordon	M	10y	3	NA	2		X		
Scheerer et al. (1945)	L	M	11y	3	Before 5y	1		X		
Silberberg and Silberberg (1968)	Case 1	F	7y1m	4	NA	2				X
	Case 2	M	Grade 4	4	NA	2				X
	Case 3	F	3y	4	18 months	2	X			
	Case 4	M	Grade 2	4	NA	1				X
	Case 5	M	8y2m	4	NA	3				X
	Case 6	M	Grade 3	4	NA	3				X
Cain (1969)	Case 1: Millie	F	6y5m	4	NA	1	X			
	Case 2: Janey	F	7y	4	NA	2	X			
	Case 3: George	M	8y	4	NA	1	X			
Goodman (1972)	Case: Sam	M	7y11m	4	Before 4y	2	X			
Mehegan and Dreifuss (1972)	Case 1: 6 6.0	M	6y	4	NA	1	X			
	Case 2	M	7y	4	3y5m	3	X			
	Case 3	M	9y	3	6y	1	X			
	Case 4: 8.0	M	8y	3	5y	1	X			
Huttenlocher and Huttenlocher (1973)	Case 1: M.K.	M	7y	3	4y	1	X			
	Case 2: C.O.	M	4y11m	4	3y	1	X			
	Case 3: B.D.	M	5y	3	5y	1	X			
Cobrinik, 1974	Case 1: Anthony B.	M	12y6m	4	2y	1	X			
	Case 2: Robert C.	M	14y6m	4	Before 5y	2	X			
	Case 3: Terence D.	M	14y	4	Before 5y	2	X			
	Case 4: John M.	M	15y	4	Before 5y	1	X			
	Case 5: Malcolm P.	M	12y	4	Before 5y	2	X			
	Case 6: William W.	M	14y	4	Before 5y	3	X			
Elliott and Needleman (1976)	Case 1: V.	F	5y8m	3	1y3m	1		X		
Aram et al. (1984)	Case: MD	M	39y	4	4y5m	2	X			
Goldberg and Rothermel (1984)	Case 1: M.H.	F	17y8m	4	3y	2		X		
	Case 2: D.M.	M	6y8m	4	3y	2		X		
	Case 3: C.K.	M	8y8m	4	3y6m	1		X		
	Case 4: D.S.	M	5y3m	4	Before 4y	1		X		
	Case 5: T.M.	M	12y6m	3	4y6m	2	X			
Goldberg and Rothermel (1984)	Case 6: C.R.	M	10y1m	4	2y	2		X		
	Case 7: L.N.	M	5y2m	4	3y	2		X		
	Case 8: A.C.	M	12y4m	3	2y	2	X			
(continued)										
Siegel (1984)	Case: A.E.	F	7y9m	3	3y	1		X		
Burd et al. (1985)	Case: B.F.	M	7y	4	4y	2	X			
Burd and Kerbeshian (1985)	Case: W.	M	11y	4	NA	2	X			
Cossu Marshall (1986)	Case 1	F	12y5m	3	NA	2			X	
	Case 2	F	18y6m	3	NA	2			X	
Burd et al. (1987)	Case 1: A.	F	NA	4	Before 3y	1	X			
	Case 2: R.	M	NA	4	4y	2	X			
	Case 3: E.	M	28y	4	5y	2	X			
	Case 4: B.	M	NA	4	3y	2	X			
Lebrun et al.	Isabelle	F	9y	3	5y	3				X

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